

## WE CLAIM:

1 1. A method for preventing motion/saturation from  
2 corrupting image capturing during a global exposure time of  
3 a sensor, comprising:

4 performing for each pixel of said sensor:

5 a) determining a difference between an  
6 illumination measurement obtained during current image  
7 capturing and an illumination estimation generated  
8 during previous image capturing;

9 b) comparing said difference with a threshold  
10 value; and

11 c) determining, based on step b), whether  
12 motion/saturation has occurred.

1 2. The method of claim 1, further comprising:

2 d1) accepting said illumination measurement and  
3 updating said illumination estimation if  
4 motion/saturation has not occurred;

5 d2) updating said illumination estimation with  
6 said illumination measurement if motion/saturation has  
7 occurred but terminating said performing act is  
8 deferred; and

9 d3) terminating said performing act and  
10 outputting said illumination estimation as final  
11 illumination estimation if motion/saturation has  
12 occurred.

1 3. The method of claim 1, wherein said threshold value is  
2 generated based on a predetermined parameter and a  
3 prediction variable, said predetermined parameter is

4 configured to achieve desired tradeoff between signal-to-  
5 noise ratio and motion blur.

1 4. The method of claim 1, wherein said image capturing  
2 occurs a multiplicity of times during said global exposure  
3 time thereby producing a multiplicity of measurements and  
4 wherein an optimal illumination estimation for said sensor  
5 is generated based on said multiplicity of measurements.

1 5. The method of claim 4, wherein said optimal  
2 illumination estimation is generated based on maximum  
3 likelihood.

1 6. The method of claim 4, wherein said optimal  
2 illumination estimation is generated based on linear  
3 minimum mean square error.

1 7. The method of claim 1, wherein said image capturing  
2 occurs a multiplicity of times during said global exposure  
3 time thereby producing a multiplicity of measurements and  
4 wherein an optimal illumination estimation for said sensor  
5 is generated based on selectively accepted multiplicity of  
6 measurements.

1 8. The method of claim 7, wherein said optimal  
2 illumination estimation is generated based on maximum  
3 likelihood.

1 9. The method of claim 7, wherein said optimal  
2 illumination estimation is generated based on linear  
3 minimum mean square error.

1 10. The method of claim 1, wherein each pixel's effective

2 exposure time is adaptive to its own lighting condition  
3 thereby enabling performing for each pixel independently of  
4 other pixels' lighting conditions.

1 11. The method of claim 1, wherein each pixel is capable  
2 of terminating its own exposure time thereby enabling  
3 extending said global exposure time.

1 12. The method of claim 11, wherein said global exposure  
2 time is limited by motion and saturation only thereby  
3 enabling said sensor to achieve higher signal-to-noise  
4 ratio and dynamic range.

5 13. The method of claim 1, wherein said steps a)-c) are  
6 performed based on parameters calculated recursively, said  
7 parameters including said weighting coefficient, overall  
8 variance, and covariance.

1 14. The method of claim 1, wherein said steps a)-c) are  
2 performed based on parameters calculated non-recursively.

1 15. The method of claim 1, wherein said illumination  
2 estimation is generated based on maximum likelihood.

1 16. The method of claim 1, wherein said illumination  
2 estimation is generated based on linear minimum mean square  
3 error.

1 17. The method of claim 1, further comprising:  
2 utilizing a soft decision rule for preventing error  
3 accumulation due to slow motion.

1 18. The method of claim 17, wherein said threshold value  
2 is characterized by a first range of values and a second  
3 range of values that include said first range of values,  
4 wherein said first range of values is characterized by a  
5 first constant parameter  $m_1$  and said second range of values  
6 is characterized by a second constant parameter  $m_2$  where  $0 <$   
7  $m_1 < m_2$ , and wherein  $m_1$ ,  $m_2$ , and length of global exposure  
8 time are chosen so to achieve a desirable balance between  
9 highest possible signal-to-noise ratio and least possible  
10 motion blur.

1 19. The method of claim 18, wherein step c) further  
2 comprising:

3 c1) indicating no motion/saturation has occurred and  
4 updating said illumination estimation with said  
5 illumination measurement, if said difference falls within  
6 said first range of values; and

7 c2) indicating motion/saturation has occurred and,  
8 1) if said difference falls outside said second  
9 range of values, terminating said performing act  
10 and using said illumination estimation for  
11 generating an optimal illumination estimation for  
12 said sensor; and  
13 2) if said difference falls between said first  
14 range of values and said second range of values,  
15 deferring terminating said performing act and  
16 updating said illumination estimation with said  
17 illumination measurement.

1 22. A method for synthesizing from multiple captures high  
2 dynamic range motion blur free images, said method  
3 comprising the steps of:

- 4 a) capturing a first image sample;  
5 b) generating for each pixel a current illumination  
6 estimation based on said first captured image sample;  
7 c) capturing a next image sample;  
8 d) determining for each pixel whether  
9 motion/saturation has occurred and whether to include said  
10 next image sample;  
11 e) repeat steps c) and d) until no more image  
12 samples are to be captured.

1 23. The method of claim 22, wherein said step d) further  
2 comprising:

- 3 d1) if motion/saturation has occurred, using said  
4 current illumination as final illumination estimation; and  
5 d2) if no motion/saturation has occurred or a  
6 decision is deferred, including said next image sample and  
7 updating said current illumination.

1 24. A system having a sensor capable of capturing a  
2 multiplicity of image samples during a global exposure  
3 time, comprising:

- 4 motion/saturation detecting means for determining for  
5 each pixel whether motion/saturation has occurred between a  
6 previous capturing and a current capturing;  
7 processing means for determining for each pixel  
8 whether to accept an image sample captured during said  
9 current capturing;

10       estimating means for generating an optimal  
11       illumination estimation for said sensor based on  
12       selectively accepted multiplicity of image samples captured  
13       during said global exposure time thereby preventing  
14       motion/saturation from corrupting image capturing.

1       25. The system of claim 24, further comprising:

2       means for determining for each pixel a difference  
3       between an illumination measurement obtained during said  
4       current capturing and an illumination estimation generated  
5       during said previous capturing;

6       means for comparing for each pixel said difference  
7       with a threshold value;

8       means for updating for each pixel said illumination  
9       estimation with an accepted or deferred illumination  
10       measurement; and

11       means for outputting for each pixel a final  
12       illumination estimation.

1       26. The system of claim 25, wherein said threshold value  
2       is generated based on a predetermined parameter and a  
3       prediction variable, said predetermined parameter is  
4       configured to achieve desired tradeoff between signal-to-  
5       noise ratio and motion blur.

1       27. The system of claim 25, wherein said threshold value  
2       is characterized by a first range of values and a second  
3       range of values that include said first range of values,  
4       wherein said first range of values is characterized by a  
5       first constant parameter  $m_1$  and said second range of values  
6       is characterized by a second constant parameter  $m_2$  where  $0 <$

7  $m_1 < m_2$ , and wherein  $m_1$ ,  $m_2$ , and length of global exposure  
8 time are chosen so to achieve a desirable balance between  
9 highest possible signal-to-noise ratio and least possible  
10 motion blur

1 28. The system of claim 27, further comprising:

2 a soft decision means for preventing error

3 accumulation due to slow motion, said soft decision means

4 indicating no motion/saturation has occurred and

5 updating said illumination estimation with said

6 illumination measurement, if said difference falls

7 within said first range of values;

8 indicating motion/saturation has occurred and

9 outputting said illumination estimation as said final

10 illumination estimation, if said difference falls

11 outside said second range of values; and

12 indicating motion/saturation has occurred and

13 said illumination measurement is deferred, and

14 updating said illumination estimation with said

15 deferred illumination measurement, if said difference

16 falls between said first range of values and said

17 second range of values.

18 29. The system of claim 24, wherein each pixel's effective  
19 exposure time is adaptive to its own lighting condition  
20 thereby enabling performing for each pixel independently of  
21 other pixels' lighting conditions.

1 30. The system of claim 24, wherein each pixel is capable  
2 of terminating its own exposure time thereby enabling  
3 extending said global exposure time.

1 31. The system of claim 30, wherein said global exposure  
2 time is limited by motion and saturation only thereby  
3 enabling said sensor to achieve higher signal-to-noise  
4 ratio and dynamic range.

1 32. The system of claim 24, wherein said motion/saturation  
2 detecting means utilizes parameters calculated recursively.

1 33. The system of claim 24, wherein said motion/saturation  
2 detecting means utilizes parameters calculated non-  
3 recursively.

1 34. The system of claim 24, wherein said estimating means  
2 is characterized as recursive.

1 35. The system of claim 24, wherein said estimating means  
2 is characterized as non-recursive.

1 36. The system of claim 24, wherein said estimating means  
2 is configured based on maximum likelihood.

1 37. The system of claim 24, wherein said estimating means  
2 is configured based on linear minimum mean square error.

1 38. The system of claim 24, wherein said motion/saturation  
2 detecting means and said estimating means are implemented  
3 based on a self-reset pixel architecture.

1 39. The system of claim 38, wherein said self-reset pixel  
2 architecture utilizes self-reset digital pixel sensors.

1 40. The system of claim 24, wherein said system is  
2 implemented on a single chip.



1     41. The system of claim 24, wherein said sensor is a  
2     digital pixel sensor.

42. The system of claim 24, wherein said sensor is a photodiode and said illumination measurement represents a charge accumulated from photocurrent produced by said photodiode.

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